THE Chemical Age

VOL. LXXV | 15 SEPTEMBER 1956 | No. 1940

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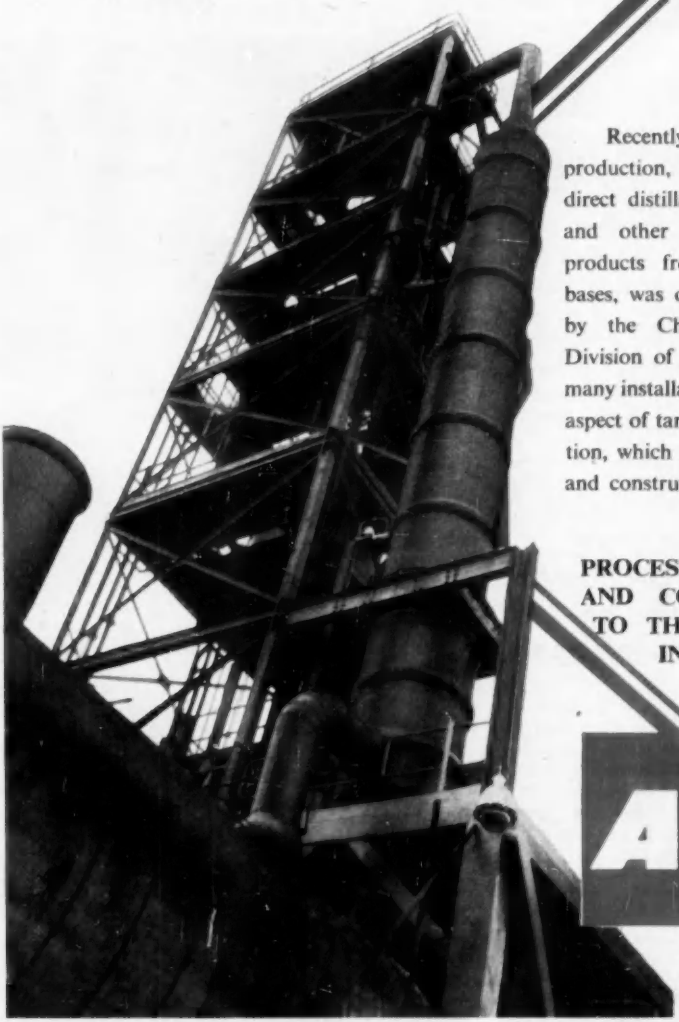

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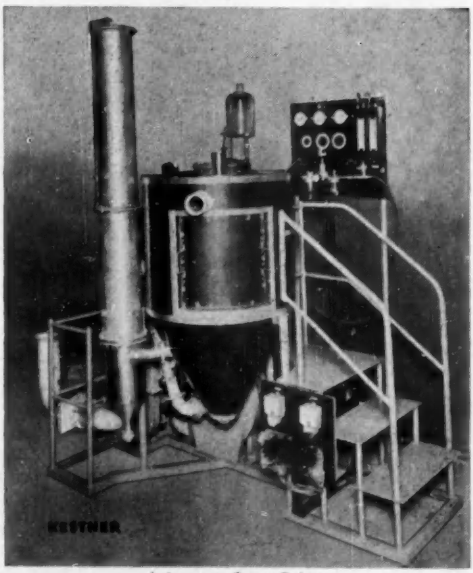

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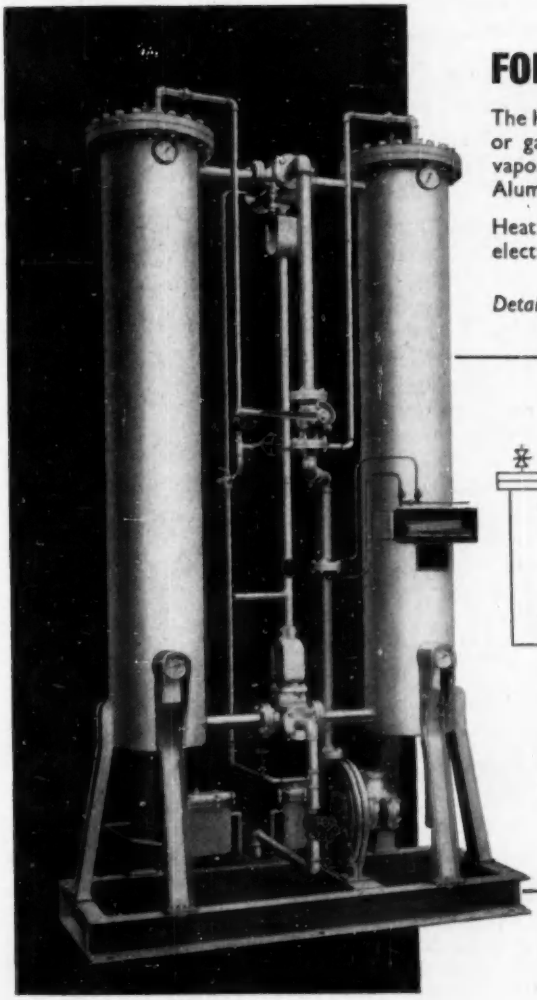

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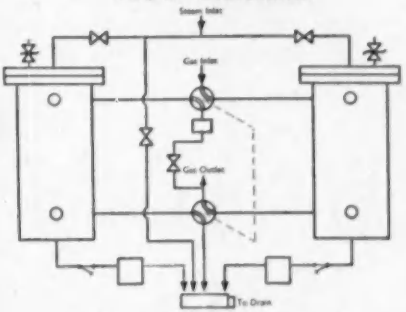

The flow diagram is of a typical instrument air dryer arranged for steam re-activation.
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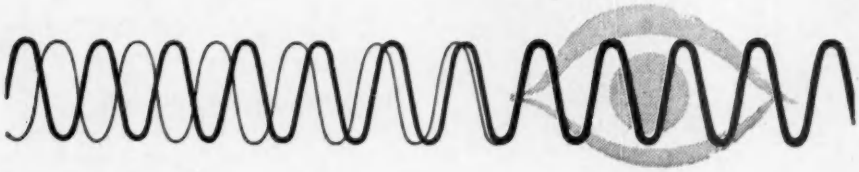

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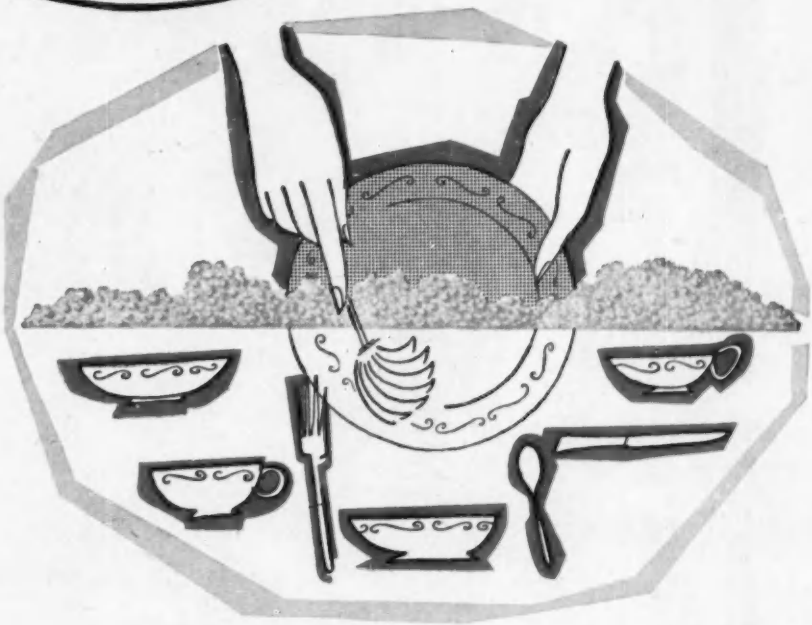

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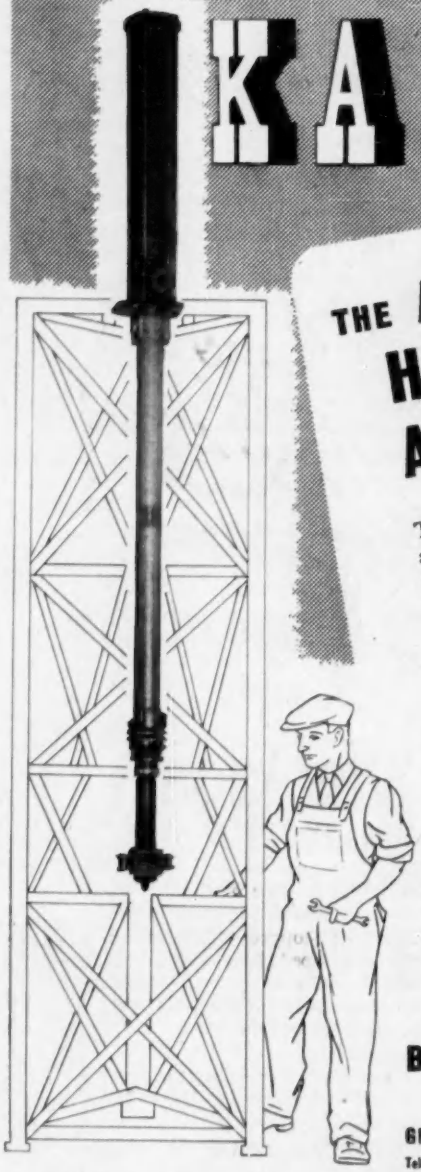

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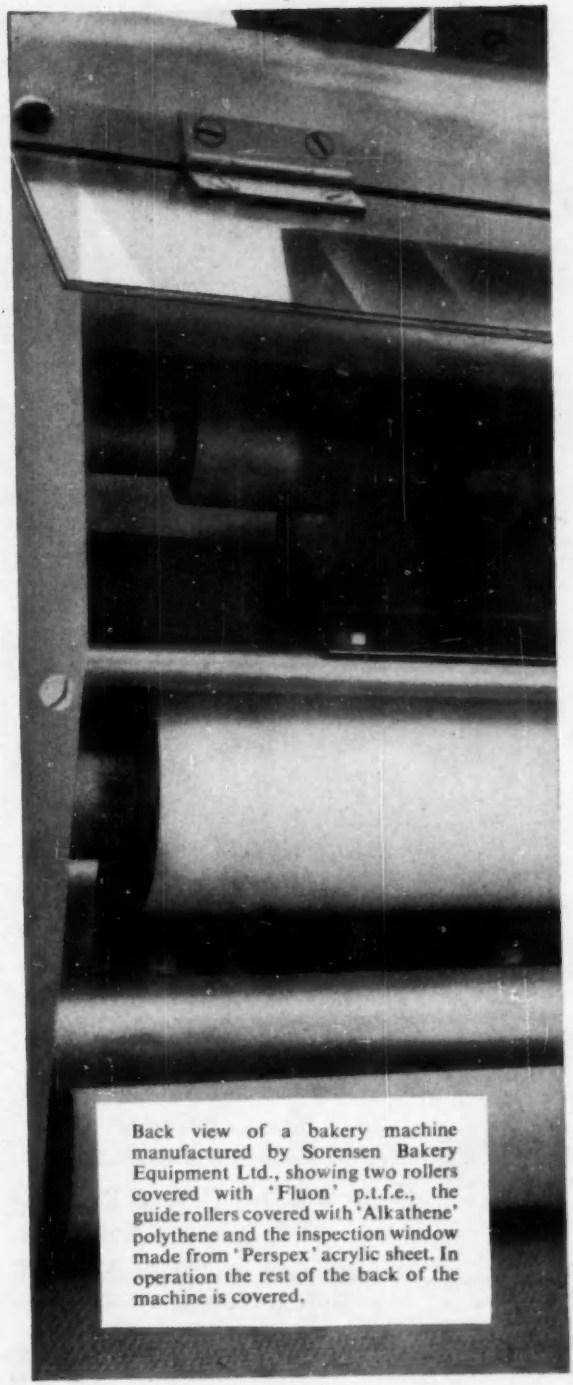

Back view of a bakery machine manufactured by Sorensen Bakery Equipment Ltd., showing two rollers covered with 'Fluon' p.t.f.e., the guide rollers covered with 'Alkathene' polythene and the inspection window made from 'Perspex' acrylic sheet. In operation the rest of the back of the machine is covered.

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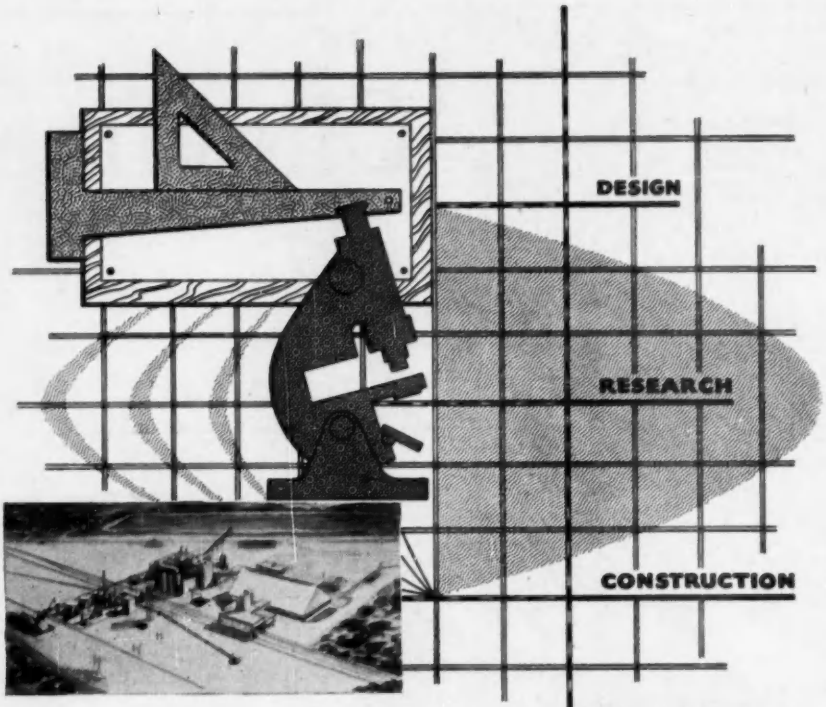

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Cars and Chemicals

A VISIT to the forthcoming international shows of commercial vehicles and motor cars at Earls Court, London, should markedly emphasise the impact of vehicles of all types on chemical economy.

Demands for chemicals by the motor industry have increased over the past 30 years and particularly since World War II. But increased output of vehicles is not the sole factor responsible for this; design changes and improvements noticeably affect chemical demand.

Modern cars now contain much more glass than the earlier models. Because of the dangers of ordinary glass, the safety variety has been developed. Through laminated glass in the late 1920s, then celluloid with its disadvantages of discoloration and brittleness, to plasticised cellulose acetate for safety glass in the 1930s, research has led to glasses which are non-splinterable, can be curved, dyed and which selectively absorb the sun's radiations.

Paints for vehicle bodies have developed too. In the early days of the motor industry, primer, rough stuff and colour varnish were applied. By mid-1930 synthetic enamels were used and the modern car has a cellulose finish. Solvents required in car spraying have undergone changes. Ethyl acetate in lacquers has been almost completely replaced by methyl ethyl ketone. Colours have changed and light pastel shades have become increasingly popular. This colour change has resulted in the use of an increased amount of titanium dioxide. In the US today, the amount of titanium dioxide used in car lacquer finish has increased to 12 times the amount used in 1941. Now synthetic organic paints, such as the acrylic type lacquers and the newly-developed refrigerator type enamels are being tried out.

Plastic materials are being introduced more and more in the car industry—vinyl polymers for upholstery, acrylic plastics for convertible tops and, by virtue of their resistance to breakage, weathering and non-distortion of light, for tail-light lenses and direction signals. The thermoplastic, nylon polyamide resin, was used in 1951, in non-lubricated door-latch wedges, followed by moulded speedometer gears. Within the last year or so, bodies of reinforced plastic have been produced. It is almost certain that this use of plastics will advance spectacularly. Standard models already contain much plastic material, such as steering wheels, control knobs and instrument panels.

Chemicals have played a major part in tyre manufacture. The early tyre was formulated of natural rubber with zinc oxide to act as reinforcing agent and promote vulcanising reaction. The modern tyre is composed largely of synthetic rubber with carbon black and other chemicals, while nylon is taking the place of cotton and rayon. Synthetic rubber is also much used in other functional parts of motor vehicles, especially where oil resistance is required as in seals, gaskets and connecting hose.

Synthetic rubbers may eventually replace metal petrol tanks, feed lines, and even bumpers. To this end, the motor industry can be expected to demand of chemists new types of synthetic rubbers.

There is a large market for chemicals in motor vehicle assembly. Chemical products are vitally concerned in keeping vehicles on the road. With new engine designs has come the need for special fuels. A quick review of the fuel requirements of the various types of ground transport engines, i.e. petrol, Diesel, gas turbine and free piston, clearly shows the demands of the petroleum industry on the chemist.

Today, the most important properties of petrol are octane value, volatility and avoidance of deposition of harmful residues on engine parts. The average compression ratio of 8.5:1 of modern cars, which results in higher temperatures and pressures and greater uncontrolled combustion (spark knock), demands a high octane fuel (90 octane) for satisfactory performance. Within the last few weeks a 100 octane fuel has been marketed in this country. It is suggested that by 1960, cars will require fuels of 100 octane plus because compression ratios will increase to 10:1 or higher. Much research is, therefore, being carried out to produce superior fuels at lower costs and to improve the chemical additives as at present used. Chemical additives may also prove of considerable importance in reducing the amount of unburned material in the exhaust.

The future of heavy and light oils is difficult to evaluate, since it will be dependent on changes in automotive and rail transportation. The Diesel engine appears to be confined to heavy-duty vehicles, though current developments may give rise to its greater use for lighter transport work. Increased performance will be demanded of oil fuels, together with elimination of 'knock' and less soot formation per pound of fuel consumed. Additives to reduce fuel-pouring temperature and to enhance operation in severe cold are being sought. Air pollution due to exhaust smoke has yet to be overcome. Analysis shows that unburned hydrocarbon, aldehydes, acids and other chemicals are contained in it. Additives which improve combustibility would therefore make a marked contribution to overcoming air pollution. Another problem associated with heavy fuels is storage stability. Suitable chemical additives can prevent such untoward effects as plugged filters and sticking injector plungers due to sediment and soluble gums. Other additives are being investigated for preventing fuel-water emulsions and rusting.

Gas turbine engines are of interest in automotive industry and their large scale production is not likely to be long delayed. Turbines do not require high octane fuels and, indeed, experimental units are operating on paraffin and leaded petrols. But special fuels for turbines will require to have good burning quality and carbon formation. Fuels with a wide boiling range and low octane number are satisfactory, although sulphur content has to be low to minimise corrosion and exhaust odour. Such fuels could be prepared from low octane fractions, paraffin and even diesel fuels. New-type additives will have to be found since the present ones cannot be used in turbine fuels.

Problems concerned with the efficient running of the free piston engine are mechanical and associated with suitable lubrication of the hot running piston.

From this survey, it is obvious that the motor-vehicle industry has influenced chemical consumption and that demand for chemicals and chemical products will continue to increase. The next few years will see many changes in refining techniques, with an ever-increasing pure chemical basis to fuels. With the development of higher compression ratios of modern cars, high octane fuels will be the regular grade in demand. At the same time development of Diesel and gas turbine engines will produce a demand for more middle distillate fuels.

Careful and continued long-term planning by the chemical and petroleum industries is necessary so as to keep abreast of all changes in the automobile and allied industries.

NEWS BRIEFS

Baird & Tatlock at IUPAC

Baird & Tatlock (London) Ltd. exhibited at the Congress of the International Union of Pure & Applied Chemistry at Lisbon, Portugal, from 9 to 15 September 1956. The following instruments were on show:— BTL micro combustion unit for carbon and hydrogen using the 'open tube technique'; BTL magnetic mercury cathode electrolytic analysis apparatus; BTL Astip oil testing centrifuge; BTL Van Slyke gas analysis apparatus; BTL infra-red heating unit; electrothermal bunsen; and a selection of BTL magnetic stirrers.

ICI to Open New Laboratories

Extensive new technical service laboratories at ICI's plastics division, Welwyn Garden City, will be formally opened on Friday 28 September. Claimed to be the finest and best equipped of their type in the world, the laboratories have been designed to facilitate the development of newer and better raw materials for the plastics industry, and to provide comprehensive technical service to users of plastics at home and abroad.

Magnesium Price

Base price in 10,000 pound lots of 99.8 per cent magnesium ingot sold by Magnesium Company of Canada to Canadian customers is 35½ cents per pound f.o.b., Arvida, Quebec works. The previous price was 31½ cents. The company is a wholly-owned subsidiary of Aluminium Ltd.

Dieldrin for Moth-proofing

In a letter to the Bradford *Telegraph and Argus* of 5 September, Shell Chemical Co. Ltd., states that dieldrin, now used extensively as a general insecticide, is being test-marketed as a moth-proofing agent. Investigations on similar lines are being carried out by the Wool Industries Research Association. Dieldrin is manufactured exclusively by Shell Chemical Co. Ltd., and is marketed in the UK by this company.

US Rubber Stocks

US synthetic rubber stocks have increased from about 170,000 tons at the end of June to about 188,000 tons at the end of July, states the US Natural Rubber Bureau. This increase amounts to 10 per cent in one month, compared with a stock of only 102,000 tons of natural rubber.

Technical Advisory Service Started

A technical advisory service to put firms who have technical problems in touch with other firms and research organisations prepared to give advice was started on 4 September by the Birmingham Productivity Association with the aid of a grant from the DSIR. Cooperation is reported to have been promised so far by 38 of the 40 firms approached by the DSIR and 50 trade research associations, and by Birmingham University and Birmingham College of Technology, who have accumulated information which they want to share with industry.

Distilling Plant Fatality

One man died and another was overcome by fumes while attempting a rescue at the by-products plant of Brancepeth colliery coke works on 7 September. The dead man was found in a pool of benzole in the distilling section. The worker who attempted the rescue was overcome by fumes.

Euratom Plans

Six European countries—France, West Germany, Italy, Belgium, Holland and Luxembourg—have set up a 'study association' for the creation of Europe's first joint plant for enriched uranium. The countries propose an atomic energy organisation (Euratom) on a joint basis.

Hess Office in Birmingham

Hess Products Ltd., and A. Hess & Bros. Ltd., of Leeds, manufacturers of Distec fatty acids and wool grease stearines and oleines, have opened a Birmingham office at:— 191 Corporation Street (Telephone Central 3891).

UK Oil Consumption Higher

In the first half of this year Britain used 12,640,000 tons of petroleum products, 8 per cent more than a year ago. The increasing use of oil instead of coal in industry appears to have been mainly responsible; consumption of fuel oil was 20.6 per cent up at 3,340,000 tons.

Pneu-technique Exhibition

Pneumatic units and instruments which can be used, either singly or combined in various ways to bring to process variables the ease and accuracy of automation, will be shown in London on 27 and 28 September. Negretti & Zambra Ltd., the scientific instrument makers, are arranging a 'Pneu-technique' exhibition at the Criterion, Piccadilly, London W1. Members of the technical staff will be there to show the instruments, explain their workings and answer questions.

Tred Symposium

ONE HUNDRED AND EIGHTY people associated with the chemical, rubber, plastics and footwear industries attended a three-day symposium on Tred, Monsanto Chemicals high styrene butadiene copolymers for rubber reinforcement, at the company's applications research centre at Fulmer Hall, Bucks, from 11 to 13 September.

On the opening day of the symposium three visitors from Manchester arrived at Fulmer by helicopter.

Dr. W. McG. Morgan, manager, presided. Mr. Michael W. Waugh, manager, rubber chemicals sales group, dealt with marketing aspects of Tred. He said that high styrene resins have been available from the US, Canada and Germany for some years but their large-scale production in the UK has not hitherto been undertaken. Tred 50 and Tred 85, at present available on pilot plant scale, will shortly be produced at Monsanto's Newport plant. (THE CHEMICAL AGE, 18 August).

Price is likely to be about 2s 6d per lb. for Tred 50 and 3s 3d per lb. for Tred 85.

Technical aspects of the resins were outlined by Mr. Kenneth R. Taylor of Monsanto's applicational research group. He explained that both resins are free flowing materials and can be weighed out and mixed with a minimum of difficulty. They are thermoplastic during mixing and materially assist processing by giving easily workable stocks. They remain thermoplastic right up to vulcanisation and are fairly stable in normal storage conditions.

Although the largest outlet for Tred resins is shoe soling, their properties make them interesting for other applications such as: flooring tiles, household utensils, fishnet floats and frogmen's flippers, TV masts, automotive parts and electrical fittings, refrigerator lids, garden hose, oil resisting rubbers, foam latex, golf ball covers and leather-like finishes.

In connection with the symposium, an exhibition showing the many applications of Tred was staged at Fulmer Hall. Monsano's documentary film 'The World that Nature Forgot' was also shown.

Fertiliser Plant for El Salvador

The Government of El Salvador is hoping to establish a fertiliser plant at an estimated cost of 50 million colones. The plant, it is claimed, would be the largest in Latin America.

Reactor School Building

SIR JOHN COCKCROFT, F.R.S., spoke at the opening ceremony of a new building for the Harwell Reactor School when it started its new course on 10 September. The new building allows more students from the UK and overseas to be accommodated and has enabled the number of courses to be increased to meet demands from industry, universities and technical colleges.

Students will receive a three-month course of instruction which includes about 150 lectures, each of one hour's duration, and visits to various nuclear reactors, either in operation or under construction. They will also perform various experiments concerned with the measurment of physical and engineering data necessary for reactor design and construction. Many of these experiments will involve the use of the Harwell reactor, BEPO.

For the first time since the School opened in September 1954, a six weeks' course is being offered concurrently with the three months' course. This will be the first six weeks of the standard course and will be concerned mainly with the fundamental physical and engineering principles in reactor design.

Styrene Monomer Plant

AT a cost of £1,750,000, a new plant for producing styrene monomer is to be built by Petrochemicals Ltd. at Partington, Lancs. A considerable amount of the output will go to Styrene Products Ltd., a Petrochemicals Ltd. associate, for the manufacture of polystyrene moulding powders.

It is from this plant, which is expected to be in operation during 1958, that the International Synthetic Rubber Organisation will draw substantial quantities of styrene for the manufacture of synthetic rubber at Fawley.

Butadiene Production

Production of butadiene at the new plant of the International Synthetic Rubber Co. (THE CHEMICAL AGE, 25 August) will be 50,000 tons a year, according to information given to a meeting of chemical and rubber experts in Buckingham on 11 September.

Austrian Nitro-fertilisers

Output of nitro-fertilisers by leading Austrian fertiliser manufacturers is expected to be 600,000 tons this year, compared with 570,000 last year.

NOTE & COMMENT

ANOTHER NEW polythene is being produced in the US. It has been given the trade name Hyrad and is said to stand continuous exposure to 300° F and brief exposures to temperatures as high as 480°F. A Californian company is already producing this material as a wire-coating. Only limited information about production details seems to be available, but the major fact—that irradiation is used in the process, employing an electron beam generator—has been released in *Chemical Engineering* (1956, **63, 8,** 122). It is also said that Du Pont, whose Teflon-coated wire sells at about twice the price, is negotiating a licencing arrangement to make the new Hyrad polythene.

Other uses for this modified form of polythene can be visualised. Tubing for hot liquids and chemicals, joints, splices, lugs etc., could be moulded from it. The irradiation generator now being used for coated wire, however, gives only a small penetration—no more than ¼ of an inch. Also, the irradiation must be applied to the polythene when it is in its final shape; if the cross-linking produced by irradiation takes place earlier, although this brings heat resistance, it does not overcome the 'memory elasticity' of normal polythene. This means that for the production of bigger articles, greater penetrating irradiation must be applied. It seems clear, therefore, that wider development of the new high-temperature polythene will require the use of electron sources such as cobalt-60 or considerably higher-voltage generators than the 1-mev. machine now being used for wire production.

Research on this new synthetic material began only two years ago as a joint project by the Californian company (Sequoia Process Corporation) and the Stanford Research Institute. It is more than two years ago that Harwell studies of the effects of irradiation upon plastics materials were first revealed. Is this yet another example of British scientific origination being speedily followed by US adaptation? The question is not asked petulantly. If elsewhere there are better facilities for developing new ideas, no one can grumble that developments take place at a speed we cannot emulate.

Oil Palms & Fertilisers

THE WORLD-WIDE influence of Britain's oldest agricultural research centre, Rothamsted, is not always appreciated. In the annual report from Rothamsted for 1955 long-term fertiliser experiments on African oil palms are reported. These experiments, mainly sited in Nigeria, were initiated by the late Dr. E. M. Crowther. Now records covering some 14 years and a total of 16,000 palms are available, a volume of evidence modestly described as 'exceptional in the annals of field experimentation.'

As plant-nutritional theory would always have indicated, the response to potash is the most consistent and important. For most kinds of carbohydrate production by plants, potash proves to be the dominant major food. Phosphate had useful effects on very sandy soils, but its effects were inconsistent on heavier soils. Again this follows theory, for the bigger and deeper rooted permanent plants have always seemed much better foragers for soil phosphate than smaller annual plants, though this do-it-yourself capacity for phosphate-winning may be of limited help on thin, sandy soils with little phosphate reserve to be foraged. There seemed small need for nitrogen and positive results were not obtained from applications of limestone or magnesium-containing materials. So, inasmuch as fertilisers can contribute towards an expanded output of palm oil, potash must apparently play the main part.

Thorium Determination

A NEW reagent for the determination of Thorium has been investigated at the National Physical Laboratory of India (Verma *et al.*, *Nature*, 1956, **178,** 324). Several organic acids have been used for quantitative precipitation of thorium. Careful control of *p*H value has been

required to separate thorium from the rare earths, and in most cases, for quantitative determination the precipitate of indeterminate composition has to be ignited to thorium oxide and weighed. The Indian investigators have found that *m*-nitro cinnamic acid not only gives a clear-cut separation of thorium from other trivalent rare-earth ions, but also gives a thorium precipitate of definite composition. It is of interest to note that this precipitated thorium salt is the tetra-*m*-nitro cinnamate and is one of the few examples of precipitation of thorium as the tetravalent salt. The method employed is as follows: An alcoholic solution of *m*-nitro cinnamic acid is added to the solution of thorium salt at *p*H 2.0 or less and *p*H adjusted 3.8 to 4. (The higher *p*H value is necessary when sulphate ions are present.) The precipitate obtained is filtered, washed with hot alcohol and weighed as thorium tetra-*m*-nitro cinnamate. The same method may be used to separate thorium from trivalent rare earths although if the proportion of rare earths is high, a double precipitation may be followed. Tetravalent ions which also interfere are titanium, zirconium, cerium.

Uncommon Sense

IN *The Percolator*—which has nothing to do with coffee growing or making but is the magazine of the Chemists' Club, New York—there are extracts from an address by Mr. R. Lindlay Murray, chairman of the Hooker Electrochemical Co., Niagara Falls. This is on the subject of looking after a 'growth company,' which Mr. Murray defines 'as one that has grown at a faster rate than the average of all companies and gives every evidence of continuing to do so.' So many chemical companies in the world can thus be defined today, as Mr. Murray's modesty about his own company's success showed—'the fact is that we have been to some extent almost automatic beneficiaries of being part of a growth industry . . . as manufacturers of chemical products we could hardly fail to grow.'

Mr. Murray refuses to associate growth with dramatic events—a new plant or a new and successful product. Growth begins 'with much less striking things—with the day-by-day decisions that result in quality products which are efficiently produced and fairly priced.' Research, sales, production, accounting, finance, etc., all these elements in the total plan have to be kept working in harmony; and for a growth-company the need for near-perfect harmony is crucially important. To achieve this is top management's principal function. Mr. Murray uses US games metaphor to put over his point about the difference between a growth company and a non-growth company. In borrowing these we have had to Anglicise them. 'A growth company makes out-of-the-ordinary demands upon its management . . . in this respect, a growth company bears about the same relation to a non-growth company that chess bears to draughts—one is vastly more demanding than the other and you must work proportionately harder to succeed.'

Nevertheless there is always the risk of 'what *Time* magazine has called the perils of table-sitting.' Because so much decision has to be reached at conference tables, the wheels of the business must not grind to a standstill while conferences confer. 'Management must be especially artful in avoiding this built-in pitfall.'

Any one who has ever been closely associated in this country with the rapid expansion of a small chemical company—whether it has been expansion for somewhat fortuitious market reasons or for special merits of the company's goods—will know what uncommon sense there is in these US comments. High-speed growth is only outwardly a success story—internally it brings many strains that are not reflected immediately in balance sheets or sales graphs; they are usually strains that reach breaking-point later on unless they are diagnosed and relieved by intelligent management at early stages. Growth constantly requires the introduction of new staff; clashes of outlook between fresh ideas and past routines are a frequent source of discord. For all these dangers, top-class top management is the surest remedy and preventive. A satisfied board of directors, however, regularly receiving good reports of expansion, can easily be oblivious to this basic requirement. Even when the existing top management is indeed top-class, it eventually goes past the point of reasonable load in many cases.

British Pharmaceutical Conference

Summaries are given below of papers of interest to chemists which were read at the recent British Pharmaceutical Conference, Dublin, 3-7 September.

TWO PAPERS read at the British Pharmaceutical Conference by W. T. Wing, of the Pharmaceutical Department, Newcastle General Hospital were on 'An Examination of Rubber used as a Closure for Containers of Injectable Solutions.' Part I has been published (*J. Pharm. Pharmacol.*, 1955, 7, 649). Part II deals with the absorption of chlorocresol. The results obtained show that the absorption of chlorocresol from aqueous solution by rubber proceeds to a state of equilibrium under controlled conditions of storage. The amount of chlorocresol absorbed bears a direct relation to the concentration of chlorcresol in the solution in contact with the rubber and the rate of absorption increases with rise of temperature. The amount absorbed is less at 37° C than at 2° C and varies with the type of rubber. The proportion of chlorocresol absorbed is much higher than with phenol. For silicone tubing it is just over 50 per cent, for translucent latex rubber tubings between 73 and 80 per cent and for other rubbers up to 91 per cent.

Part III is on the effect of the chemical composition of the rubber mix on phenol and chlorocresol absorption. Eight rubber mixes were therefore prepared containing three fillers having the possibility of chemical interaction, namely zinc oxide, magnesium carbonate and calcium carbonate and four which exert a reinforcing action to the rubber matrix, namely china clay, VN3, a precipitated silica, lampblack and philback, the remaining mix containing the curing ingredients only. All the mixes were vulcanised in a press for 12 minutes at 60 lb. per sq. in. steam pressure (approx. 153° C).

These rubbers, with the exception of the one containing VN3, showed little variation from rubber containing no filler in their phenol and chlorocresol absorption. The presence of VN3—a preciptated silica, resulted in an increased absorption which is related to VN3 content. An increase in sulphur content resulted in a slightly higher absorption of chlorocresol while an increase in zinc oxide content resulted in a slightly decreased absorption.

Three other rubber mixes were prepared containing as accelerators, (a) dipenta methylene-thiuram disulphide, (b) tetramethyl thiuram monosulphide and (c) a mixture of benzothiazyl disulphide, which breaks down to mercaptobenzothiazole and tetramethyl thiuram disulphide. These accelerators produced rubbers with a similar degree of absorption but when the accelerator Santocure (N*cyclo*hexyl-2-benzothiazol sulphenamide) was used, the rubber had a lower degree of absorption of chlorocresol and phenol than any of the other types mentioned above.

The inclusion of factice as a plasticiser caused a marked increase in phenol and chlorocresol absorption.

Surface Active Agents

In a paper on non-ionic surface active agents Mr. B. A. Mulley and Mr. A. D. Metcalf of the Pharmaceutics Laboratories, School of Pharmacy, Chelsea Polytechnic, London SW3, stated that such agents are being increasingly used as emulsifying and solubilising agents particularly in the pharmaceutical industry. The authors' paper is part of a general study of the properties of these compounds and records the solubility at 20° C of chloroxylenol (4-chloro-3:5-xylenol) in aqueous solutions of polyethylene glycol 1000 monocetyl ether (cetomacrogol 1000).

Results of experiments show that increased solubility of the phenol is due to its incorporation into micelles. This is considered to be governed by the hydrogen bonding which occurs between the phenolic hydroxyl group and the ether chain of the non-ionic surface-active agent, and is based on evidence of the ultra-violet absorption spectra of chloroxylenol in *cyclo*hexane and in solution of cetomacrogol 1000. When the molar ratio of phenol to surface-active agent exceeds about 1.9:1 it would appear that the hydrophylic character of the micelle is decreased and a complex separates containing surface-active agent, chloroxylenol and water.

New Scientific Instruments

National Pharmacy Exhibition

VARIOUS SCIENTIFIC INSTRUMENT manufacturers exhibited at the National Pharmacy Exhibition which opened on 10 September at the Victoria Halls, Bloomsbury Square, London WC1. A brief description of some of the new instruments exhibited is given below.

Adelphi Manufacturing Co. Ltd. has now fitted a new device to the Adelphi vacuum milling machine to enable it to fill thin walled plastic bottles which normally collapse under vacuum. The company also reports that a nylon version of the Adelphi gravity filling valve should shortly be available.

Exhibits by *Birlec Ltd.* related to air conditioning and dehumidification. Birlec direct dehumidifiers depend for their operation upon the adsorbent properties of activated alumina which has a great affinity for atmospheric moisture and has the added advantage that the adsorbed moisture can subsequently be driven off by moderate heating. The small BE 40 unit, suitable for conditioning small rooms with one or two occupants was displayed. Birlec laboratory Lectrodryers of both low pressure and high pressure designs were exhibited. These process gas dryers are capable of producing dew points down to −60° C continuously or intermittently for process gases, compressed air and certain volatile liquids.

An automatic titrimeter which makes a titration to a known end-point automatically was exhibited by *Electronic Instruments Ltd.* Two titration units may be used in sequence with a single control unit. The instrument may be used for either volumetric or coulometric titrimetry. The advantage in coulometric titrations is that no standard solution is required.

Electrothermal heating equipment for the laboratory was demonstrated by *Electrothermal Engineering Ltd.* An electrothermal melting point apparatus was of considerable interest, as was electrothermal insulating tape. The tape is composed of one or more fabric bands of resistance wire separated and bordered by bands of high temperature resisting glass fibre yarn. The surface loading of standard heating tapes has been arranged at 2½ watts/in.² (0.4 watts/cm.²) area of tape. This wattage concentration enables temperatures of 400° C and over to be reached inside a glass tube of 2mm. wall thickness. Other surface loadings up to 8 watts/sq. in. (1.25 watts/cm.²) are available.

A portable and self-contained deioniser specifically designed for the research laboratory is the Elgastat deioniser type B.102, marketed by *Elga Products Ltd.* The Elgastat provides up to 30 litres of purified water per hour, the quality of which exceeds that of triple quartz distilled water (conductivity water). The water is free from metals silica, chloride, sulphate, ammonia and carbon dioxide. *p*H value is 6.6-7. No power is used and no maintenance is required. All-polythene construction makes it indestructible. A conductivity meter is built-in and provides constant quality check. Ion-exchange resins are contained in a detachable cartridge which, when exhausted, is easily replaced by a new cartridge.

A miniature mixed bed deioniser, the Elgastat minor C.403, is also available. Attached to a metal still, it obviates multi-distillation.

Two types of water tester were exhibited by *Evershed & Vignoles Ltd.*: the portable Dionic water tester for examining samples and the Dionic water purity meter for continuous tests. A recording polarograph, model mark 15, which was also displayed, incorporates many new features and is stated to be the only potentiometric polarograph giving high speed permanent records, and in which the damping may be varied at will by operating a selector switch.

Colloid mills suitable for handling liquids and pastes were shown by *Premier Colloid Mills Ltd.*, together with a selection of mixers. Of particular interest were the new Premier laboratory mixer which can be used for a variety of applications where small quantities of materials have to be intimately mixed and the 3-in. multipurpose mill which has the speed to handle emulsions and suspensions together with a particularly high output for a machine of this size.

Electronic check weighers were demonstrated by the *Solartron Electronic Group Ltd.* By selection of an appropriate model an accuracy of more than 0.2 per cent can be obtained at any weight in the range from 0.1 oz. (3 g.) to 70 oz. (2.0 kg.).

UK Oil Consumption

FIGURES published by the Petroleum Information Bureau show that consumption of petroleum products in the UK during the first half of the year reached 12,639,146 tons, an increase of 8.1 per cent on the first six months of 1955.

Fuel oil, which accounted for 3,337,470 tons, again showed the highest increase—20.6 per cent—of all products over January/June 1955. Gas/Diesel oils, with a tonnage of 1,221,554, have increased by only 4.7 per cent, or a quarter of the rate at which they were expanding in June last year.

Motor spirit deliveries, at 3,064,785 tons, showed an increase of 3.1 per cent. Deliveries of derv (Diesel engined road vehicle) fuel maintained a strong increase of 12.9 per cent, bringing the total to 866,427 tons.

Demand for burning oil rose to 454,554 tons, a gain of 17.1 per cent. This was more than offset by a decline of 23.3 per cent in deliveries of vaporising oil, which amounted to 286,826 tons.

The only other products showing decreases were aviation fuels (1.2 per cent) at 849,898 tons, and lubricants (1 per cent) at 434,297 tons, but the decrease in lubricants is purely statistical, being due to a change in the conversion factor from gallons to tons, deliveries in gallons being up by one per cent. Bitumen deliveries rose 14.5 per cent to 468,664 tons.

Atomic Orders in Canada

The Crown Corporation Atomic Energy of Canada, which is co-ordinating Canada's nuclear affairs, is to expand its programme to bring private industry into specialised uranium processing. A contract of unspecified value has been awarded to A.M.F. Atomics (Canada), of Toronto, a subsidiary of American Machine & Foundry, for the production of reactor fuel rods. A.M.F. (Canada) plans to build a fuel rod plant at Port Hope, Ontario, where it will produce rods and carry out a general research and development programme in reactor fuelling.

Hungarian Exports

By virtue of a commercial agreement, still subject to ratification, between Hungary and Syria, Hungary will export to Syria equipment for the chemical and petroleum industries, laboratory and measuring instruments, and chemicals.

Chemistry Lectures

MANCHESTER & District Advisory Council for Further Education has published a booklet describing all post advanced lectures in chemistry available in the Manchester area during the session 1956-57. Information contained in the booklet falls into two parts:—

(1) Details concerning the courses in specialised branches of chemistry to be provided during the session 1956-57 on the recommendation of the Advisory Committee set up by the Council, and

(2) Details of post advanced courses in chemistry which form part of the normal provision at technical colleges in the area for the session 1956-57.

Enquiries should be addressed to the honorary secretary of the Council, Education Offices, Deansgate, Manchester 3.

Atomic Energy Courses

COURSES on the industrial and research applications of atomic energy are being run by Isotope Developments Ltd. at suitable periods of the year for the technical training of home and overseas sales representatives and service engineers.

A comprehensive theoretical and practical course was held from 3 to 15 September at the company's laboratories and works at Beenham Grange, Aldermaston, Berks. The first week of the course, at the laboratories and works, consisted of a full programme on the practical aspects of industrial equipment, laboratory counting and measuring techniques, reactor instrumentation and handling of isotopes etc. The second week was taken up with outside visits to examine the latest industrial installations and observe laboratory techniques using the company's instruments.

Italian Bitumen Output

The output of Italian bitumen obtained from petroleum residues has shown in the last five years a steady increase from 203,600 tons in 1951 to 420,000 tons in 1955. The national requirements of bitumen were fully satisfied, in the 1951-55 period, by the product of the Italian refining plants. Imports of bitumen, which had amounted (according to ISTAT statistics) to 1,576 tons in 1938 and 33,089 tons in 1946, diminished to 48 tons in 1950. Exports increased at the same time from 10,150 tons in 1951 to 75,000 tons in 1955.

PEOPLE in the NEWS

● SIR HERBERT MANZONI, Birmingham's City Engineer, who is chairman of council of the British Standards Institution, was elected president of the Institution at its annual general meeting on 4 September. He succeeds SIR ROGER DUNCALFE, chairman of British Glues & Chemicals Ltd., who in the past 20 years has held all the principal offices in BSI. MR. JOHN RYAN vice-chairman, Metal Box Co. Ltd., was re-elected vice-president of the Institution. The following were elected as representatives of BSI's chemical divisional council, to serve on the general council:— MR. G. J. CUTBUSH, a director of Metropolitan Leather Co. Ltd.; MR. G. DRING, research director, Bakelite Ltd.; and SIR KNOWLES EDGE, managing director of W. Edge & Sons Ltd.

● MR. R. MCKINNON WOOD has been appointed vice-chairman of the committee under the chairmanship of PROFESSOR WILLIS JACKSON, which will advise the Government on the recruiting and training of technical college teachers. Mr. McKinnon Wood is chairman of Griffin & George Ltd., laboratory furnishers.

● Former director-general of the BBC and chairman of the Colonial Development Corporation, LORD REITH, has been appointed a director of the British Oxygen Co. Ltd. Lord Reith sits on the boards of a number of companies. He had a long and distinguished career in the public service and held several posts in the Government between 1940 and 1945. He was the first general manager of the BBC in 1922 and from 1939 to 1940 was the first chairman of BOAC. Lord Reith is a member of the Queen's Bodyguard in Scotland, the Royal Company of Archers.

● Secretary of the Royal Society, SIR DAVID BRUNT, led the British delegation to the Advisory Council for the International Geophysical Year, which met in Barcelona from 11-15 September. The delegation also included PROFESSOR H. S. W. MASSEY, Professor of Physics, University College, London. The conference provided the last opportunity for making final detailed international arrangements for the International Geophysical Year, which commences on 1 July next.

● Progress of Plastics was the subject of a talk given to Morecambe Rotary Club by DR. D. A. HARPER, managing director of Storey's of Lancaster. Emphasising the amazing progress in the development of plastics in the last 20 years, Dr. Harper said the tonnage of articles made from plastics was now approaching that of non-ferrous metals such as brass and aluminium.

● The Carbon Dioxide Co. (a division of The Distillers Co. Ltd.) announces the appointment of MR. S. C. STEWART as director in charge of the division. Mr. Stewart, who has been a division director of The Carbon Dioxide Co. for some years, is general manager of the Industrial Alcohol Division, and a division director of the British Industrial Solvents Division of DCL.

● A British engineering delegation is to visit Russia to study engineering education and training from 16-28 September. One of the members of the delegation is PROFESSOR A. S. T. THOMSON, head of the department of mechanical, civil and chemical engineering, Royal Technical College, Glasgow. A return visit to the UK by a group of Soviet experts is being considered. In Russia the delegation of nine UK experts will visit higher technical education establishments in Moscow and Leningrad. PROFESSOR E. GIFFIN, professor of civil and mechanical engineering at London University, leads the delegation.

● MR. E. R. SUMMER has been elected a director of British Emulsifiers.

● MR. E. A. OLDFIELD, A.Met., A.I.M., has been appointed senior research officer of the Cutlery Research Council (British Iron and Steel Research Association) in succession to MR. C. N. KINGSTON.

● MR. R. P. RICHARDSON, former managing director of Burndept, has joined the board of Metachemical Processes.

● Edgar Allen & Co Ltd. have announced the appointment, as from 1 May 1956, of MR. A. P. T. TAYLOR-GILL (for many years the firm's representative in Australia and the Far East) as technical sales representative for tool steels for the North of England.

Growth of Biochemistry

by PROFESSOR F. G. YOUNG, F.R.S.,
(Department of Biochemistry, University of Cambridge)

BIOCHEMISTRY as a subject of significance in university life, and in science in general, has expanded enormously during the past 10 years, but for nearly half-a-century before it was gradually creeping into university curricula and becoming accepted as an entity in itself. The introduction of a new subject into universities is usually a slow process but since nearly a dozen new professorships have been founded since the war in Britain alone, the growth of biochemistry in recent years is indeed a rapid one.

Until the end of the 17th century the interests of chemists with one or two notable exceptions, of which Paracelsus and a few other iatrochemists were the most outstanding, had been directed largely to an examination of the substances occurring in the non-living mineral world. But in the *Cours de Chymie* (1675) written by the French chemist and physician Nicolas Lemery, the arabic classification of substances into the three kingdoms, animal, vegetable and mineral, was adopted and substances which occur in plants and animals were considered properly to fall within the scope of chemical investigation.

Vegetable & Animal Substances

During the 18th century many substances derived from vegetable, and to a less extent from animal sources, were isolated and their properties studied, but little or no attempt was made to carry out these investigations in a systematic manner. The results were in general classified according to the origin of the substances and to miscellaneous properties of them, rather than on the basis of what we now understand as chemical relationships. Because of their association with living organisms, that is with 'organised' matter, the products of the animal distinguish them from 'inorganic' materials, which made up or could be formed from inanimate matter.

Antoine Lavoisier, the great French chemist who lost his life in the French Revolution, found that organic substances are composed largely of the elements carbon, hydrogen and oxygen, together sometimes with nitrogen and less frequently phosphorus and sulphur. Since respiration in animals was found to involve an oxidation of carbon and hydrogen to carbon dioxide and water (1785), Lavoisier came to the conclusion that 'life is a chemical function'. Nevertheless most chemists still held the view that the power of building up elements into the complex substances which occur in the living organism is the sole prerogative of a special vital force or vital energy inherent in the living organism.

Wohler's Discovery

In 1828, however, the apparently unbridgeable chasm which seemed to separate the inorganic from the organic world, was crossed by the discovery of Wohler that when an inorganic salt, ammonium cyanate, was heated it was transformed into urea, a substance which occurs in urine and which up to that date had been known only as a product of the metabolism of animals. As Wohler himself wrote to Berzelius in 1828, 'I can make urea without calling on my kidneys, or indeed without the aid of any animal, be it man or dog.'

This discovery attracted rather little attention at the time and indeed Wohler himself was somewhat uncertain of its significance. Moreover this synthesis remained the only one of its kind for a good many years. So it was not until about the middle of the last century, when the artificial production of other organic substances began to be successfully carried out, that belief in a vital force and in the existence of a fundamental difference between inorganic and organic substances was abandoned. It was about this time also that the term 'organic' begun to lose its original connotation and to be applied to the apparently limitless compounds or carbon, whether these substances were derived from living matter or not.

Achievements of organic chemistry during the first half of the 19th century, particularly in Germany, were spectacular.

One would have expected that with the rapidly growing subject of organic chemistry

Abridged version of evening discourse delivered at the British Association meeting in Sheffield on 31 August.

of processes in living systems, biochemistry in essence, would have grown apace during the nineteenth century. Nevertheless it is disappointing but true that a large proportion of chemists particularly of those in Britain, remained unconcerned by the possibilities of investigations in the field of biology. The chemical structure of many of the substances of importance in biological process was too complex to yield quickly to the analytical processes then available to chemists; moreover the attractions of synthetic organic chemistry began to multiply and the rich prizes that appeared in the shape of synthetic dyes, perfumes and fabrics, proved to be strong. And so in the second half of the 19th century the advances in the chemistry of substances of biological importance were as meagre as they were spectacular in the first half of the 20th century.

A Sad Reflection

It is at once an interesting and sad reflection that during the 19th century almost no British chemist or physicist of international reputation turned serious attention to the study of the phenomena of life, and particularly to those of animal life, despite the fact that so many distinguished continental chemists found, in biology, an irresistible attraction. One has but to name in Germany Liebig, Wohler, Pettenkofer, Voit, Hoppe-Seyler and Emil Fischer; in Sweden Berzelius; in France Pasteur, Lavoisior, Dumas, Claude Bernard (although he is commonly regarded as a physiologist he was particularly concerned in some of his investigations in the application of chemical knowledge to biological problems) and Pasteur; in Britain Thomas Graham in 1862 showed that the particles of a colloidal solution would not pass through a parchment membrane, and applied this method of analysis to biological material, while later in the century (1860-80) Thudichum, an immigrant from Germany, laid the foundations of our knowledge of complex fatty materials. At the time it was done Thudichum's work was largely ignored, while Thomas Graham's researches had no strong effect on the development of animal chemistry in Britain at the time.

Why did British chemists so widely ignore the possibility of applying their knowledge to biological systems in general and to animal metabolism in particular?

No simple answer can be given to such a complex question as this, but it is of interest to note that the cherishing of household pets,

Growth of

which is such a conspicious aspect of the Englishman's habits today, seems to bring itself to notice from about the early years of last century. This development on a national scale of a sentimental affection for animals. leading as it did to strong anti-vivisectionist movements, may well have held back many who might otherwise have applied there scientific aptitudes to the experimental investigation of animal life.

Another factor that undoubtedly contributed in the latter part of the last century to a stunting in Great Britain of the potential development of experimental biology (in which biochemistry may be included) were the controversies that captured the imagination of many thinking people after the publication of Charles Darwin's *Origin of Species* in 1859. Those who were engaged in relentless verbal battles about matters which clearly could not be settled by experiment were less likely to turn to the application of chemistry and physics to the phenomena of animal life than those who were not taken up in such speculative animosities. To me it is illuminating that when Pettenkofer and Voit decided to investigate the heat production of the animal body, they came to London to obtain a Thompson calorimeter in 1860 because in this country calorimetry had been so highly developed. But little interest was taken in this country, either at that time or subsequently, in the application of the calorimeter to the measurement of animal heat.

Development of Enzymes

During the past century the development of ideas about ferments, or enzymes as we now call them, was of paramount importance in the growth of biochemistry. Alcoholic fermentation is a process that has been known for as long as men have been civilised or even longer. The fact that such a fermentation normally depends upon the presence of a living system was not realised until the discovery of Cagniard-Latour in 1836 that yeast is a living organism.

In the early years of the present century the investigations of Harden and Young at the Lister Institute in London, revealed the importance of substances formed by a combination between sugars and phosphoric acid in alcoholic fermentation, and later the work of Embden, Myerhof and others in Germany, and of Dorothy Needham in this country,

Biochemistry

showed striking similarities between the metabolic processes involved in alcoholic fermentation by yeast and in muscular contraction in frogs and mammals. More recently the researches of Calvin in America, among others, have demonstrated remarkable similarities between certain pathways of carbohydrate breakdown in animals and those processes whereby carbohydrate is built up under the influence of light in the green plant.

In general, the development of biochemistry over the past 50 years has laid bare what can be called a common ground plan of function with respect to all biological systems. It is indeed exciting to realise that the metabolic processes of microorganisms, plants and animals (including higher animals) all have elements in common which would be unrecognisable without the activities of the biochemist.

The modern era of biochemistry in this country was ushered in under the influence of the late Sir Frederick Gowland Hopkins (1861-1947), the first professor of biochemistry in the University of Cambridge, who must be regarded as a significant catalyst for the growth of biochemistry in general.

Birth of Vitamins

In 1906 Hopkins described experiments which he had carried out on the possibility of rearing and maintaining an animal on a completely artificial diet, the rat being a suitable laboratory object for this end. From the results of these experiments, he deduced the existence of what he called accessory food factors, present in a normal diet, and insignificant as a source of energy but nevertheless of greatest importance for the development and health of the animal. These researches were the birth of the general idea of vitamins.

Since that time, as the result of the work of Hopkins and his colleagues and of many others, it has been realised that many of these vitamins enter into the constitution of catalytic systems of the cell and there are converted into coenzymes and so assist the oxidation of foodstuffs. Such vitamins can be common to man and microorganism. It was with work of this sort that Hopkins was able to direct the attention of biochemists to events which take place within the cell, and it is with these problems above all that biochemists have been concerned, during the last 50 years.

The many investigations on vitamins which have taken place during the past 40 years or so have allowed human nutrition to be treated on a rational basis never before possible. The successful application of laboratory principles on a nation-wide scale was demonstrated by the work of the Ministry of Food during the past war, with Sir Jack Drummond as the Chief Scientific Adviser.

Development of BAL

Another aspect in which biochemical investigation has resulted in a practical significance wider than might be expected lies in the development of BAL by Sir Rudolph Peters and his colleagues at Oxford during the war. The discovery of this substance, based on essentially biochemical ideas, arose from the need to provide an antidote for the war gas lewisite. But subsequently BAL has turned out to have application as an antidote to a number of toxic substances, and has therefore found a place in the medical armamenterium.

Dr. Frederick Sanger, of the department of biochemistry, University of Cambridge, has recently successfully completed an investigation which he began in 1945 and which was designed to reveal the structure of the hormone insulin, a substance which hundreds of thousands of diabetic patients all over the world have to inject into themselves each day. Dr. Sanger's investigation has elucidated for the first time the complete structure of a protein, and the possibility that a substance as complex as insulin may now yield to synthesis in the laboratory is one that has the greatest theoretical and practical importance.

The biochemistry of micro-organisms is a subject that has flourished in Britain during the past 50 years. The late Dr. Marjory Stephenson took up this subject in the early 1920s under the stimulus of Sir Frederick Gowland Hopkins. Her two pupils, Professor Donald Woods at Oxford, and Dr. Ernest Gale at Cambridge, are doing much to throw light on the biochemical mechanism of bacteria and the means whereby antibacterial substances may exert their action. The Woods-Fildes hypothesis, put forward in

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From all Quarters

Portuguese Chemicals

Cost of production of certain chemicals which form the raw materials of various industries producing for export, has been reduced, the Portuguese Under-Secretary of State for Commerce and Industry has announced. The supply through pipelines of brine made from rock salt and of electricity at special prices will result, it is hoped, in the reduction of prices of several products by sums varying from 140 to 1,500 escudos a ton which equal from 8 to 30 per cent of the price. The materials in question are sodium carbonate, caustic soda and chlorine. Recently there have been striking increases in Portuguese purchases from the UK of chemical elements and compounds (1955: £275,000; 1956: £334,000) and other chemicals (1955: £324,000; 1956: £415,000).

Uranium in Rhodesia

Although no workable deposit of uranium has yet been found in Rhodesia, enough has been discovered, states the United Kingdom Atomic Energy Authority in Salisbury, to suggest that there might be large deposits.

US Consumption of Explosives

Consumption of industrial explosives in the US reached a record total of 806,878,221 lb. in 1955, an increase of 13 per cent over the 715,955,276 lb. used in 1954, according to the Bureau of Mines, US Department of the Interior.

World Metallurgical Congress

Twenty-eight scientists from the UK are expected to attend the 2nd World Metallurgical Congress at Chicago, US, in November next year. Germany will probably send 34 scientists. Ultimate attendance is expected to exceed 500 from some 35 countries. The congress is being sponsored by the American Society for Metals.

Argentina Authorises Imports

Circular No. 2,577 issued by the Banco Central of Argentina states that it has been decided temporarily to authorise imports of black aniline, excluding sulphuric acid and azoic (Tariff No. 4318) and coloured aniline, excluding sulphide (Tariff No. 4319), at the free market rate of exchange without prior permit.

S. Vietnam I.C.A. Credits

Under new import procedure allocations of funds for imports under the I.C.A. programme are to be given quarterly. Among the items for which funds are to be made available for the quarter July to September this year are: chemical products, $3½ including $2,675,000 on Procurement Authorisations expected but not yet notified; and, scientific instruments, $300,000 on Procurement Authorisations expected but not yet notified.

Huber Processes for Carbon Plant

Robert B. Takewell, executive vice-president of the J. M. Huber Corporation, announces that Huber manufacturing processes will be utilised in the design of the new carbon black plant to be erected near Melbourne, Australia. The plant will be owned jointly by United Carbon Co. Inc. and Shell Petroleum Co., and will produce standard grades of carbon black, matching the corresponding American types. The Huber company will participate in the distribution of the production of the plant in Australia.

Dow Buys Particle Accelerators

Dow Chemical Co. has purchased two 2-million-volt Van de Graaff particle accelerators for basic studies in radiation chemistry. Installation of the two machines, both manufactured by High Voltage Engineering Corp., Cambridge, Mass., will bring to three the number of super-voltage units now in use by the Dow organisation. The company is at present using a 2-million-volt Van de Graaff accelerator for activation analysis and radiation chemistry.

Detergents for Portugal

Manufacture of solid and liquid detergents for domestic and industrial use is to be undertaken by Sonade—Sociedade Nacional de Detergentes, S.A.R.L. Avenida Fontes Pereira de Melo, 39, 5°D, Lisbon. The company has been set up by Campanhia Uniao Fabril with other commercial interests. There is already widespread interest in domestic detergents due to heavy advertising campaigns by two British companies.

Degradation of Polysaccharides

Alkaline Hydrolysis of Glycosidic Linkage

By Bengt Lindberg

The alkaline hydrolysis of glycosidic linkages is of importance in connection with the degradation of polysaccharides and other reactions during alkaline cooking.

The most important types of alkali labile glycosides are phenyl glycosides and glycosides of β-substituted alcohols, where the β-substituent is an electron acceptor. The reaction mechanisms for the hydrolysis of these glycosides are briefly summarised.

It has now been observed that ordinary alkyl glycosides, such as methyl β-D-glucopyranoside and cellobitol, are degraded by alkali under drastic conditions, e.g., 10 per cent aqueous sodium hydroxide at 170°. Preliminary results indicate a reaction mechanism analogous to that for the alkaline hydrolysis of phenyl glycosides.

An interpretation of the degradation of polysaccharides during alkaline cooking is suggested, based on these new observations together with previous results.

This article is published by permission of 'Svensk Papperstidning,' from the issue of 15 August 1956. The author is in the Division of Wood Chemistry, Royal Institute of Technology & Wood Chemistry Department, Forest Products Research Laboratory, Stockholm.

ALTHOUGH the glycoside linkage is generally considered to be stable to alkali, there are several types of alkali-labile glycosides known. The field has recently been summarised by Ballou (1). Phenyl glycosides and the glycosides of β-substituted alcohols, in which the substituent is an electron acceptor, are the two types most important to the wood chemist.

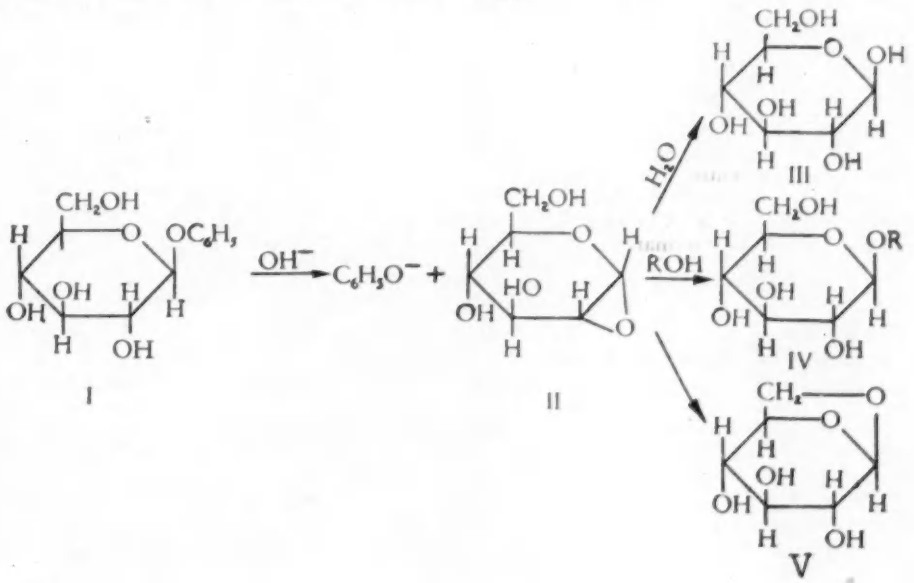
The first step in the alkaline hydrolysis of phenyl β-D-glucopyranoside (I) is the formation of the phenoxide ion and the epoxide (II). The latter is quite labile and reacts with hydroxyl groups in one of the following ways:

(a) With water, with the formation of glucose (III), which is decomposed in the alkaline medium.

(b) With an alcoholic hydroxyl to give a β-glucoside (IV).

(c) With the hydroxyl group at $C_{(6)}$ to form an internal glucoside, levoglucosan (V).

The same type of reactions occur with other phenyl glycosides, e.g. β-galactosides and β-xylosides, for the latter, however, the



c

formation of an internal glycoside, analogous to levoglucosan, is of course excluded. For some other glycosides, e.g. α-galactosides and β-mannosides, the mechanism described above is impossible for steric reasons, and the degradation follows other routes; generally the velocity constants for these reactions are considerably smaller.

If there are linkages of a glycosidic nature between the lignin and the hemicellulose in wood, reactions of the type discussed above could be of importance during pulping under alkaline conditions. The question of whether linkages between lignin and hemicelluloses really exist, however, cannot be considered at all settled and the nature of these potential linkages is naturally quite unknown.

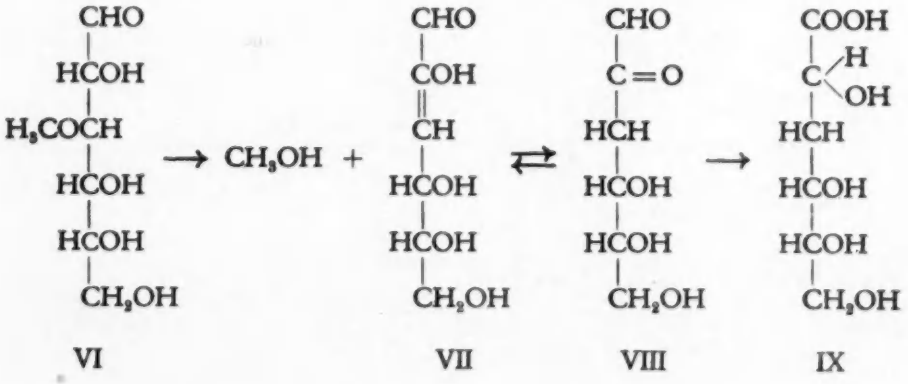
Alkali Lability

In the other important type of alkali labile glycosides, the glycosides of β-substituted alcohols, the β-substituent should be an electron acceptor, such as a carbonyl, a nitro or a sulphate ester group. The alkali lability is not restricted to glycosidic linkages, since the ethers of sugars are also hydrolysed in analogous reactions, in which the free reducing group of the sugar functions as the electron acceptor. The mechanism of these degradations, which include sugar ethers, glucosides, oligosaccharides and polysaccharides, is now fully understood, chiefly due to the extensive investigations by Kenner and his coworkers. A summary of their results has recently been published (**2**). The reactions are exemplified below for the alkaline degradations of 3-*O*-methyl-D-glucose and of cellulose.

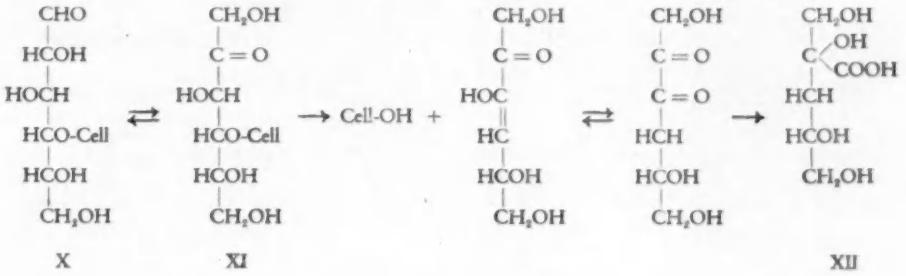
The first step in the degradation of 3-*O*-methyl-D-glucose (VI) is the elimination of methanol with the formation of the enol (VII), which is in equilibrium with the dicarbonyl compound (VIII). This then rearranges to metasaccharinic acid (IX) in a reaction analogous to the benzilic acid rearrangement.

In cellulose (X) a glycosidic linkage is in γ-position to the aldehydic end group, but this carbonyl can migrate to $C_{(2)}$ in an alkaline medium, as exemplified by the equilibrium set up between glucose, mannose and fructose in the presence of alkali. In this form (XI), the glycosidic linkage is in β-position to the carbonyl group and the degradation proceeds as described above for the 3-*O*-methyl-D-glucose. As the carbonyl group has shifted, another acid, isosaccharinic acid (XII) is formed as end product. The residual cellulose molecule, one glucose unit shorter, contains a new reducing end group and the degradation could proceed by the same mechanism until the whole molecule is degraded, the reaction being known as the 'peeling' reaction.

Samuelson and Wennerblom (**3**) studied the degradation of cellulose by alkaline cooking. They found that the degradation started from the carbonyl groups, probably the reducing end groups, and that on the average about 50 glucose units were peeled off before the reaction chain was broken by the oxidation of the aldehydic end group to a carboxyl group. The cause of this oxidation is not known; it might be due to traces of oxygen present or to a 'crossed' Cannizzaro reaction between the end group and a degradation product. Samuelson and Wennerblom also found that the reaction



VI VII VIII IX

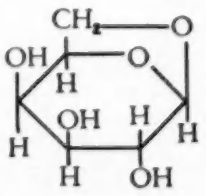


did not come to an end, as would be expected, when the number of carboxyl end groups formed was equivalent to the number of carbonyl groups in the original sample if this were the only reaction leading to degradation. Consequently the degradation must also be due to other, unknown reactions, which probably lead to the formation of new, reducing end groups. About 1.4 equivalents of acid were formed for each molecule of glucose split off, so that in addition to the hydrolysis there must also occur considerable fragmentation.

In order to study these reactions further we have treated a number of glycosides with alkali under drastic conditions; 10 per cent aqueous sodium hydroxide at 170° for several hours. The reactions were carried out in small steel autoclaves with oxygen excluded. The results of these preliminary investigations are summarised below.

1 The substances investigated, cellobitol, lactitol and maltitol and various alkyl-glucosides, galactosides and xylosides were all partially decomposed with the formation of acidic products.

2 Methyl-α-D-glucopyranoside, methyl-α-D-galactopyranoside and moltitol were all considerably more stable than the isomeric methyl-β-D-glucopyranoside, methyl-β-D-galactopyranoside and cellobitol.



XIII

3 Sorbitol was isolated from the degradation products of cellobitol and of lactitol.

4 1.6-anhydro-D-galactose (XIII) was isolated in a low yield from the degradation products of lactitol.

5 No levoglucosan (V) could be isolated from the degradation products of cellobitol. A chromatographic investigation of the reaction products, however, indicated its presence in small amounts, but it was demonstrated in a separate experiment that levoglucosan itself is considerably less stable than the ordinary β-D-glucosides investigated.

The idea that the glycosidic linkage, with the exceptions discussed above and in reference 1, is stable to alkali must obviously be modified. It is probably more correct to say that glycosidic linkages are generally hydrolysed by alkali, but that the velocity constants for different glycosides vary widely. The velocity constants observed for the alkaline hydrolysis of a number of phenyl β-D-glucopyranosides covered a range of several powers of 10 (4). Similar differences will probably be found for different glycosidic linkages in alkyl glycosides, oligosaccharides and polysaccharides, which are all rather resistant to alkaline hydrolysis but can be cleaved if the conditions are drastic enough.

The isolation of 1.6-anhydro-D-galactose (XIII) from the lactitol degradation products and the fact that the β-glucosides and β-galactosides reacted much faster than the corresponding α-glycosides, indicates that the mechanism for the degradation might be analogous to that shown to occur in the alkaline hydrolysis of the corresponding phenyl glycosides, discussed above and in reference 1. More detailed investigations of the reactions between glycosides and alkali, including the relative stability of various glycosidic linkages and the nature of the

degradation products, is under progress. The experimental part of the present, preliminary investigation, will be published in connection with those investigations.

From previous results and from those obtained now the degradation of polysaccharides during alkaline pulping processes may be interpreted as follows.

1 The degradation starts from the reducing end groups and other carbonyl groups present (oxycellulose) and proceeds as a 'peeling reaction.' discussed above.
2 New reducing end groups are formed by the alkaline hydrolysis of glycosidic linkages. As levoglucosan is less stable than ordinary glycosides, the potential formation of 1.6-anhydrides by this reaction will not stabilise the hydrolysis products, but the degradation will continue according to the 'peeling' reaction. Even if a very low percentage of the glycosidic bonds is hydrolysed by the first reaction, the degradation of the polysaccharide might be considerable as each cleavage initiates a 'peeling' reaction.
3 The 'peeling' reaction is broken by the oxidation of the aldehydic end groups to carboxyl groups. The nature of the oxidant is unknown.

The author is indebted to Mrs. Elisabeth Dryselius, Mr. Göran Annergren and Mr. William Vösu for their skilful assistance.

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(1) Ballou, *Advanc. Carbohyd. Chem.*, 1954, **9**, 59.
(2) Kenner, *Chem. & Ind*, 1955, 727.
(3) Dyfverman, & Lindberg, *Acta chem. scand.*, 1950, **4**, 878.
(4) Samuelson, & Wennerblom, *Svensk Papp-Tidn*, 1945, **57**, 827.

Corrosion Resistant Fabric

A POROUS, woven fabric for the manufacture of industrial garments requiring resistance to corrosive chemicals is now being made by David Whitehead & Sons Ltd. of Lancashire and London.

The staple fibre is called Dynel (manufactured by Carbide and Carbon Chemicals Co.) and is a vinyl chloride-acrylonitrile material distributed in this country by Gemec Chemicals Co. Dynel is claimed to be resistant to almost the entire range of industrial chemicals. It is not intended to replace pvc but rather the ordinary cotton cloth used in protective clothing which has a relatively short life due to attack from acid and alkali. Dynel will not support combustion, it is stated.

Growth of Biochemistry

from page 493

1940 jointly by Professor Woods and Sir Paul Fildes, which suggests that chemotherapeutic agents may sometimes be chemical caricatures of vitamins which the microbe fails to distinguish from the substance it needs and so hopelessly clogs its metabolic machinery with a damaging foreign agent.

Penicillin was discovered by Sir Alexander Fleming, a bacteriologist, and developed by Sir Howard Florey, a pathologist. Its isolation depended upon the co-operation of a biochemist, Dr. E. B. Chain. The subject of antibiotics of microbial origin, which is clearly of the greatest importance in the pharmaceutical industry, has been developed most successfully in the US.

Nobel Prizewinners

Since the war three Nobel prizewinners in this country have been biochemists. In 1952 A. J. P. Martin and R. L. M. Synge shared the Nobel prize for chemistry, for their investigations which led to the development of partition chromatography, a method which, in its application in all branches of scientific endeavour in which chemical methods can be used, has had a tremendous effect. In 1953 H. A. Krebs, now professor of biochemistry at Oxford, shared the Nobel prize for medicine with F. Lipmann of the US. The investigations of Professor Krebs have been particularly concerned with the mechanisms involved in intermediary metabolism and the factors which determine their rate.

The recent isolation and characterisation of vitamin B_{12} by a team led by Dr. E. Lester Smith of Glaxo Laboratories Ltd. is a tribute to the long-sightedness of this organisation.

In these times of technological development, biochemistry ought to contribute its share. There is clearly room for the development of what one might call biochemical engineering, the application of biochemical ideas on a large scale. The production of substances such as penicillin from microorganisms is one example. Although on more than one occasion Sir Harold Hartley has emphasised the importance to the chemical engineering of the future of biochemical engineering, there still exists a reluctance on the part of some in industry to appreciate the potential value of biochemistry.

PRODUCTION OF TITANIUM

Right, remote control of titanium melting furnaces by television

NUMEROUS developments in titanium production in this country and the US are announced this week.

Methods for making consumable electrodes, used increasingly by industry in melting easily contaminated metals, like titanium, are described in a US Bureau of Mines report released by the Department of the Interior.

The report was prepared by technologists at the Bureau's Northwest Electrodevelopment Laboratory in Albany, Oreg., where considerable research has been done on consumable electrode melting.

Pointing out that no single method of making electrodes is suitable for all types of material, authors of the report summarise information on five electrode-production techniques:—pressing sponge metal or crushed chips of metal into briquettes; electrical sintering of short stacks of briquettes formed under low pressure; joining briquettes by spot or strip welding; assembling electrodes directly from massive scrap by welding; and joining ingots made in a small furnace to produce a consumable electrode for a larger furnace.

General Requirements

General requirements for consumable electrodes, such as strength, conductivity, purity, and straightness, also are discussed by the authors, R. A. Beall and F. W. Wood, physicists, and P. C. Magnusson, electrical engineer, all of the Albany laboratory. Many illustrations supplement the text of the report.

Copies of the report, *Report of Investigations 5247, Fabricating Consumable Electrodes of Zirconium, Titanium, and Similar Metals for Arc Melting*, can be obtained from the Bureau of Mines, Publications-Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

ICI announces that it is using television to assist in the remote control of titanium melting furnaces at its Metals Division plant in Birmingham.

It is just 12 months since ICI commissioned two new plants for producing 1,500 tons a year of raw titanium and melting it for conversion into massive and wrought forms.

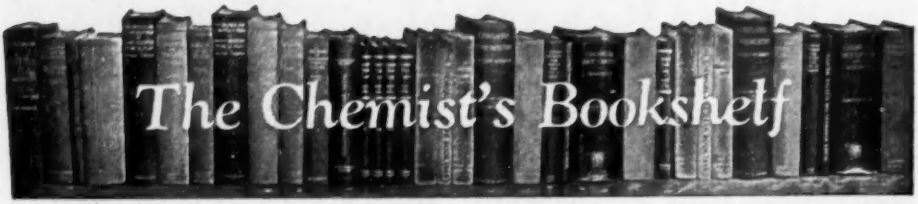
Experience in melting and fabricating titanium is being gained so rapidly that equipment and techniques operating a year ago are now regarded as obsolete. For example, the melting furnaces at the ICI factory at Birmingham are all being changed to accommodate much larger ingots. The latest type operate by remote control, so that some means had to be devised to watch the progress of melting.

The photograph shows the method adopted—the use of a Pye industrial camera control unit. The image on the five-inch screen shows what is happening inside the furnace, where raw titanium is melting at a temperature of 1,660° C to form an ingot.

A considerable amount of new information about titanium is contained in the second edition of *Wrought Titanium*, published this week by ICI's Metals Division.

This revised publication outlines the properties and availability of ICI titanium and, in the present state of knowledge, is inevitably incomplete. Further editions, contemplated from time to time, will take account of new developments and keep the information on the subject as up to date as possible.

The booklet reveals that ICI is installing a new rod rolling plant of advanced design for the production of rolled rod and certain simple sections. The opportunity is being taken to rationalise the range of sizes produced. Since most round rod is centreless ground it is convenient to use decimal sizes, the range of which has been based on the system of preferred numbers (BS 2045 and BS 1638 R20 series).



MARGARINE AND OTHER FOOD FATS, THEIR HISTORY, PRODUCTION AND USE. By M. K. Schwitzer. Leonard Hill (Books) Ltd., London. 1956. Pp. xvi + 385. 46s.

This book is concerned with the whole range of food fats, such as butter, cream, lard, olive oil, and particularly with margarine. The principle food fats are first described, then follows an interesting account of the history and social implications of the margarine industry. Two detailed chapters describe the extraction of animal and vegetable fats, and refining and hydrogenation processes. A short theoretical chapter on the rheology and emulsification of fats is followed by a detailed description of the manufacture of margarine and cooking fats. Problems of packaging, distribution and preservation are then dealt with. Aspects of the use of fats, for example in the manufacture of biscuits and bread, are discussed. The concluding chapter deals briefly with nutritional and legal aspects of fats.

Numerous references and a detailed bibliography are given at the end of each chapter. There are many excellent tables and flow sheets, and over 20 photographs; these depict, *inter alia*, the grinding of olives in France, deck scenes on a whaler, and automatic margarine moulding and wrapping machines. The book is well written, and is unusually free from blemishes; 'hydrogenatious catalysts' appears on p. 191, and 'degradates' on p. 268.

Use of Margarine Increasing

Although it is primarily intended for the expert, the book contains much of great general interest. We learn that the use of margarine and similar materials is spreading rapidly, to regions where liquid fats are traditonal. In India, vanaspati ghee is widely replacing buffalo butter; production has risen from 500 tons in 1930 to 172,000 tons in 1950, by which year nearly 50 factories were operating.

In some countries, margarine is used extensively in frying; exudation of water droplets from the molten fat is liable to cause spattering, and special emulsifiers are added to prevent this. Antioxidants are often added to fats to prevent rancidity; it is earnestly hoped that such additives as thiodipropionic acid, butylated hydroxyanisole, or nor-dihydroguaiaretic acid do not become fashionable on this side of the Atlantic!

Apart from its general interest, the book will certainly be invaluable to public analysts, food technologists, and food chemists. However, the author himself carefully points out that book learning is not sufficient for margarine manufacture: the *chef de cuisine* touch is also required.—

W. W.

PRODUCTION OF HEAVY WATER. Edited by G. M. Murphy. McGraw-Hill Book Co. Inc., New York & London. 1955. Pp. 394. 39s 6d.

This volume continues the series prepared as a record of the American Atomic Energy Commission. Its subject, at first sight, appears divorced from the more familiar process industries but here lies the moral of application from which chemical engineering developed. The book details most fully studies on exchange reaction, distillation and extraction processes applied to the production of heavy water. These date from the early '40s and are supplemented by an extended bibliography referring largely to the original reports. The most recent references cited are part of a short bibliography dealing with azeotropic and extractive distillation which reach to 1946. The value of this book, therefore, must lie in its internal detail rather than the recent character of its content. In this case, it is adequate to give it a much more extended life than topicality would justify.

The first part consists of a report *Commercial Production of Heavy Water* covering the general operating and engineering features of

The Chemist's Bookshelf

the production plants together with a comparison of other methods which were not developed to an industrial scale. The Trail ammonia plant was the only North American plant producing adequate electrolytic hydrogen (1,300,000 lb. of H_2 per month) for use in the catalytic exchange plant. Accordingly the plant was located there. In the exchange tower the HD in the gas stream was partially converted to HDO over the catalyst bed and then absorbed in the descending water stream. Plants for the separation of the deuterium isotope by water distillation were built in several places. These were feasible since HDO and D_2O have slightly lower vapour pressures than H_2O. Both of the above methods were used for primary separation but the final concentration to 99.8 per cent D_2O was achieved by direct electrolytic concentration. The low temperature distillation of liquid hydrogen, though very promising according to the survey, was not developed within the scope of the programme described because the urgency with which the D_2O was required would not permit adequate experience to be gained of operating at such low temperatures. The other methods suggested are more briefly discussed.

This report is particularly valuable to the student because, besides development work, it describes experience gained in operating the plants and suggests where improvements are required. These descriptions are supplemented from plant records. However, a student should be discouraged from such slips as on page 31 where, in a material balance, the net distilled water input is given as one thousandth of its actual value.

The second part describes in detail laboratory and pilot plant studies for the separation processes. In particular, the development of the nickel-chromium oxide, platinum and palladium catalysts for the accepted exchange reactors is given at length. In all this work there was apparently very little use of statistical method in experimental design. This is somewhat disappointing since it would be particularly valuable to know of a book one could recommend as describing such a series of experiments designed for statistical analysis. This is, perhaps, a reflection on the age of the reports. However, as a record of an actual process development it deserves strong recommendation.—J.S.M.B.

Eye Irrigation Fountains

AMONG particulars of new products brought recently to the notice of RoSPA and mentioned in its *Industrial Bulletin* for August is the following:

Eye irrigation Fountain.—Sanitary engineers in the UK are taking an increasing interest in this type of equipment. One leading manufacturer is now producing a wall-type hand-operated twin jet fountain and a pedestal type foot-operated twin jet fountain. Both types are chromium plated.

Also available from this firm is an emergency drench shower, for use where accidental splashing from chemicals demands instant attention. Automatic in action, the shower sends down a heavy cascade of water as soon as weight is placed on the sunken platform.

Indian Conditions

THE PROMOTERS of an oil refinery in Saurashtra, India, have been told that the Indian Government will give no guarantee against nationalisation.

The Indian Government's attitude towards the setting up of oil refineries in the future will involve conditions radically different from those under which the three existing refineries have been set up.

The Government will hold the major share of the equity capital of the companies, and the companies, which will in every case be rupee companies, will have to offer a share of the equity capital to the Indian public.

Agents for Beckman

Spectrophotometers and other instruments manufactured by Beckman Instruments Inc. have been supplied in this country by A. Gallenkamp & Co. Ltd., authorised agents for Beckman. These instruments are available, subject to import licence, from the Beckman factories in Western Germany and the US. Service by Beckman trained technicians is available from Gallenkamp.

Silver Jubilee

The British Colour Council's Silver Jubilee celebrations are planned to take place from 24 to 26 September. On 25 September Mr. R. J. Smith of Imperial Chemical Industries, dyestuffs division, will give a talk entitled 'Colour Through History'. Details of the celebrations can be obtained by writing to the Secretary, British Colour Council, 13 Portman Square, London W1.

Commercial Intelligence

The following are taken from the printed reports, but we cannot be responsible for errors that may occur.

Mortgages & Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages or Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary but such total may have been reduced.)

MICRO-BIOLOGICALS LTD., London SW.—20 August, £2,000 debentures, part of a series already registered.

SCOTT BADER & CO. LTD., Wellingborough.—14 August, debenture, to Board of Trade securing £10,000 and further advances not ex. in the aggregate £19,100; charged on specified property at Woolaston, with fixed plant, machinery etc. *Nil. 11 December 1954.

Receiverships (Appointment or Release)

CHEMO-METALS (LONDON) LTD., 295 Regent Street, London W1:—Herbert J. J. Rothschild, of 30 Greville Hall, Greville Place, London NW6, ceased to act as Receiver and/or Manager on 15 August 1956.

NEWBALL & MASON LTD., manufacturing chemists etc., Beech Avenue, Nottingham:—William R. Coope, of 9 Clarendon Street, Nottingham, ceased to act as Receiver on 15 August 1956.

Increases of Capital

UCLAF LTD. (568,723), manufacturers of chemical products etc., Uclaf Works, Marshgate Lane, London E15, increased by £499,000, in £1 ordinary shares, beyond the registered capital of £100.

BRADFORD CHEMICAL CO. LTD. (564,770), 61 North Parade, Bradford, increased by £9,900, in £1 ordinary shares, beyond the registered capital of £100.

VIADUCT ALUM CO. LTD. (176,655), The Marsh, Widnes, increased by £9,000, in £1 ordinary shares, beyond the registered capital of £12,000.

ORTHO PHARMACEUTICAL LTD., Lane End, High Wycombe, increased by £30,000, in £1 ordinary shares, beyond the registered capital of £20,000.

STANDARD SYNTHETICS LTD., manufacturers of synthetic chemicals, drugs, essential oils etc., 76 Glenthorn Road, London SW13, increased by £9,900, in 1s ordinary shares, beyond the registered capital of £100.

Changes of Name

SWEDISH ASTRA A. B. (LONDON) LTD., manufacturing, wholesale and retail and analytical chemists etc., 7 Arundel Street, London WC2 changed to Astrapharm Ltd., on 12 July 1956.

GS TRADING CO. LTD., 11a Southgate Street, Winchester, Hants, changed to GS Chemicals Ltd., on 5 July 1956.

SURFACTANTS & ALLIED CHEMICALS LTD. 17 Station Road, Swinton, to Plastic Compounds Ltd., on 5 July 1956.

MARSH PHARMACY LTD. 48 Marsh Street, Hanley, Stoke-on-Trent, changed to Marsh Toilet Supplies & Cosmetics Ltd., on 13 July 1956.

MERCK-SHARP & DOHME LTD., chemists and druggists, oil and colourmen etc., West Hill, Hertford Road, Hoddesdon, Herts, changed to Merck Sharp & Dohme Ltd., on 18 July 1956.

New Companies

Coliclean Ltd.

Private company (571,202). Registered 6 September. Capital £100 in £1 shares. Objects: To carry on the business of manufacturers of and dealers in chemical, pharmaceutical, medicinal and other preparations etc. The subscribers (each with one share) are:—Stanley A. Schiff, 14 St. Anthony's Avenue, Woodford Green, Essex, chartered accountant; and Ross H. Allen, 59 Longridge Road, London SW5, audit clerk. The first directors are to be appointed by the subscribers. Secretary: C. A. Leat. Reg. office: 31 King's Road, London SW3.

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Company News

National Chemical Products

Group profits for the year to March 25 amounted to £161,071, compared with £149,210, after taxation, for the previous year. The acquisition of the outstanding shares in Poly-Resin Products has enabled the company to plan the wider development of its plastics division. A new licence agreement has been concluded with Reichhold Chemicals Inc., whereby technical advice on resin manufacture will be made available to the company.

Monckton Coke & Chemical Co Ltd.

Trading profits of Monckton Coke & Chemical Co. Ltd. expanded from £138,283 to £158,608 in the year ended 30 June last. The net profit of £60,204 compares with £52,208. Dividend is 200 per cent, less tax. The chairman, Mr. E. A. Norton is to resign after the annual meeting in Sheffield on 27 September. He will be succeeded by Mr. F. E. Holroyd. Mr. Norton will become deputy chairman.

Vitamins Ltd.

Profits for the year ended 31 March 1956 of Vitamins Ltd. were £106,169. A balance of £75,666 was brought forward from the previous year, making a total of £181,835. A dividend of 15 per cent is recommended on the ordinary stock and after this and other deductions are made the balance to be carried forward is £120,297. In his review of the past year the chairman, Mr. H. C. H. Graves, says that the pharmaceutical side of the business had gone ahead faster than the agricultural side. During the past year the increase in the pharmaceutical turnover was the greatest ever recorded. The same was true of the newest branch of the business—fine chemicals. The 28th annual general meeting of the company, a member of the Vitamins group of companies, will be held in London on 20 September.

Celanese Corporation of America

Directors of Celanese Corporation of America have declared a dividend of 12½ cents a share on the common stock, payable on 25 September to holders on the register on 7 September 1956. The board have voted regular quarterly dividends of $1.12½ on the preferred stock (series A) and $1.75 on the 7 per cent second preferred stock. Both preferred stock dividends are payable on 1 October.

MARKET REPORTS

LONDON The movement of industrial chemicals, in the aggregate, is about average for the time of year with new business slow to develop due to the uncertain outlook in some industries. Home demand for the general run of the soda products and potash chemicals continues steady and export business, covering a wide range of materials, is keeping up to a good level. An active trade in fertilisers has been reported with home and import supplies finding a ready outlet. As from 11 September the basic price of dry white lead is increased to £150 5s per ton, and dry red lead to £145 10s per ton, otherwise steady price conditions prevail in most sections of the market and apart from the recent reduction in the price of glycerine quotations show little alteration. The coal-tar products market is steady both as regards prices and demand with creosote oil and cresylic acid in good request. Pitch is in fair call on home account.

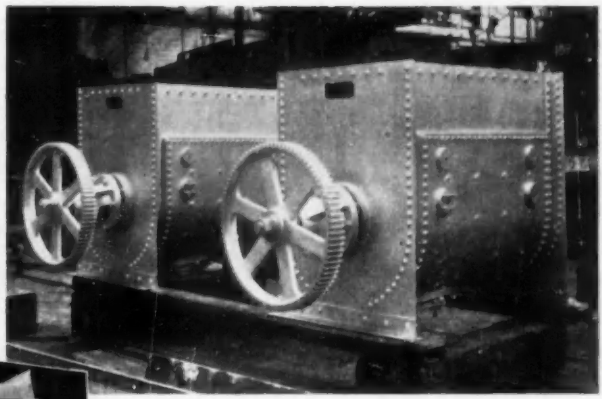
MANCHESTER Home and export enquiry on the Manchester chemical market during the past week has been on a fair scale, embracing a wide range of products. So far as contract deliveries are concerned, there is room for improvement in the call for textile chemicals. Specifications from one or two other outlets tend to cover somewhat smaller quantities than they did a short time ago, but in most other directions the demand is satisfactory. Prices are on a generally firm basis. There is a fair movement in a few fertiliser materials, including the compounds. A steady demand for most of the tar products is reported.

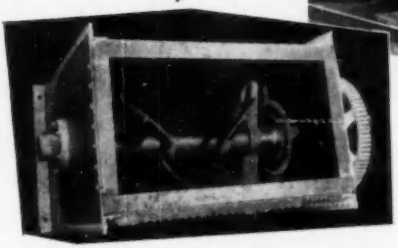
GLASGOW Trade generally in the Scottish heavy chemical market has been rather quiet, although during the past week a little improvement has been noted. Orders received have been mostly for prompt delivery, and against usual nominal requirements. Prices have remained steady, but glycerine has shown a fall. The export market continues satisfactory.

Change of Address

Hygrotherm Engineering Ltd. changed its London office address on 10 September to 5 Fitzhardinge Street, Portman Square, London W1 (Telephone Welbeck 6813).

MIXING VESSELS





These hot water jacketed Mixing Vessels capacity ½ ton each) are for use in chocolate manufacture. The lower photograph shows the stirring gear.

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APPLICATIONS are invited from well-qualified graduates in Chemistry for the post of **RESEARCH ASSISTANT** in Radiation Chemistry in the Department of Physical Chemistry of the University of Leeds. The person appointed would be required to investigate some aspect of the radiation chemistry of organic compounds and could be a candidate for a higher degree. The starting date would be arranged to suit the convenience of the successful candidate. Salary would be in the range £350-£500 per annum, the actual value depending on age, experience and qualifications. Previous research experience, especially in Physical Chemistry, is desirable but not essential. Applications should be sent to **PROFESSOR F. S. DAINTON, SCHOOL OF CHEMISTRY, THE UNIVERSITY OF LEEDS, 2.**

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APPLICATIONS are invited for two senior metallurgical appointments in Northern Rhodesia.

The appointments will be those of **REFINERY SUPERINTENDENT** and **ASSISTANT REFINERY SUPERINTENDENT** of a 110,000 long ton per year Electrolytic Copper Refinery now in course of construction at Ndola, Northern Rhodesia.

Applicants should be in possession of a University degree in Metallurgy or equivalent qualifications and have had a number of years in an adminstrative capacity in an Electrolytic Refinery and preferably also experience of fire refining. The commencing basic salary will be according to experience and qualifications, in addition to which there is a variable Copper Bonus based on the prosperity of the industry which is paying at present in excess of 50% of basic salary.

A Cost of Living Allowance also applies.

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There is a Group Pension and Life Assurance Scheme, membership of which is compulsory, and a medical Benefit Scheme for the successful applicants and their families. Married accommodation will be provided at a subsidised rental.

The successful applicants will be required to take up their appointments towards the end of 1956 or early 1957.

Free passages to Northern Rhodesia will be provided. Applications giving details of qualifications and experience, also stating age and marital status, together with a copy of a recent photograph, should be sent before the 15th October, 1956, to **THE MANAGER, NDOLA COPPER REFINERIES LIMITED, P.O. BOX 642, NDOLA, NORTHERN RHODESIA.**

BROWN & POLSON GROUP require a Food Chemist in their expanding Technical Service Division situated at Manchester. Applications are invited from men age 27-45 qualified and experienced in food chemistry. Keen to initiate ideas and produce results in new products and to assist trade customers with relevant problems. Write full details, age, education, qualifications and experience. (An indication of present or expected salary would be helpful) to the Group Personnel Manager, Brown & Polson, Ltd., 125-130, Strand, London, W.C.2.

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in various Government Departments.

The Civil Service Commissioners invite applications for pensionable posts.

The posts are divided between the following main groups and subjects: (*a*) Mathematical and Physical Sciences; (*b*) Chemistry and Metallurgy; (*c*) Biological Sciences; (*d*) Engineering Subjects; and (*e*) Miscellaneous (including e.g., Geology, Library and Technical Information Services).

AGE LIMITS.—For Experimental Officers, at least 26 and under 31 on 31 December, 1956; for Assistant Experimental Officers as least 18 and under 28 on 31 December, 1956. Extension for regular service in H.M. Forces. Candidates aged 31 or over with specialised experience for Experimental Officer posts may be admitted.

Candidates must have at least one of a number of specified qualifications. Examples are Higher School Certificate, General Certificate of Education, Scottish Leaving Certificate, Scottish Universities Preliminary Examination, Northern Ireland Senior Certificate (all in appropriate subjects and at appropriate levels), Higher National Certificate, University Degree. Candidates taking their examinations in 1956 may be admitted. Candidates without such qualifications may be admitted exceptionally on evidence of suitable experience. In general, a higher standard of qualification will be looked for in the older candidates than in the younger ones.

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Assistant Experimental Officer, £365 (at age 18) to £805 (men), £715 (women). Starting pay up to £655 (men) or £627 (women) at 26 or over. Somewhat lower outside London. Promotion prospects. Women's scales being improved under equal pay scheme.

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Further particulars, for which you are advised to make early application, from

CIVIL SERVICE COMMISSION,
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WANTED YOUNG ORGANIC CHEMIST for technical sales of industrial chemicals made by Rohm & Haas, U.S.A. and their English subsidiary. Technical sales experience required. Excellent opportunity. Send curriculum vitae to **BOX NO. C.A. 3496, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

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MIDLAND Company manufacturing Fume and Dust Collecting equipment, require the services of a **CHEMICAL ENGINEER** as a Consultant.

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SCIENTIFIC OFFICERS

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Candidates must have obtained a university degree with first or second-class honours in an appropriate scientific subject (including Engineering) or in Mathematics, or an equivalent qualification; or possess high professional attainments. Candidates for Senior Scientific Officer posts must in addition have had at least three years' post-graduate or other approved experience.

Interview Boards sit at frequent intervals.

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AGE LIMITS.—Senior Scientific Officers, between 26 and 31, but specially suitable candidates under 26 may be admitted; for Scientific Officers between 21 and 28 during 1956 (up to 31 for permanent members of the Experimental Officer class). Salary: (London), Senior Scientific Officers—(men) £1,135-£1,345; (women), £1,026-£1,240. Scientific Officers—(men) £605-£1,055; (women) £605-£962. Women's scales being improved under equal pay scheme. Somewhat lower rates in the provinces.

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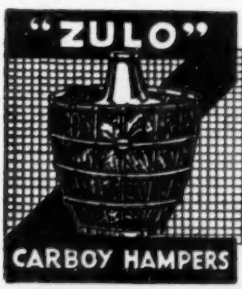

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Enquiries to:

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AMBERLITE

ION EXCHANGE RESINS

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